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(54) IMPROVEMENTS IN OR RELATING TO BELT CONVEYORS AND CONVEYOR BELTS THEREFOR

(71) We, PNEUMATIQUES CAOUTCHOUC MANUFACTURÉ ET PLASTIQUES, KLEBER-COLOMBES, a French Body Corporate, of Place de Valmy, 92 Colombes, France, and ATELIERS MECANIQUE DU DOUAISIS, a French Body Corporate, of 6, Boulevard Louis Bréguet, 59 Douai, France, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

The present invention relates to belt conveyors having a conveyor belt which moves above a base-plate or an enclosure from which it is separated by a layer of a fluid such as air or water; these conveyors, which are well known, will hereinafter be referred to as "fluid conveyors."

In the Specification to follow, reference will be made to the apparent co-efficient of friction of the belt which will be given by the ratio

$$\frac{F}{P}$$

in which P represents the loaded weight of the belt and F the force driving the loaded belt at a constant speed along a straight horizontal path.

In fluid conveyors, the total energy consumed is the sum of the energy used to form and maintain the fluid layer, which mainly depends on the amount of fluid used, and on the energy used to drive the belt, which depends directly on the apparent co-efficient of friction which itself varies (all other things being equal) with the energy used to form and maintain the fluid layer: it decreases when the latter is increased and increases when the latter is decreased.

In existing fluid conveyors, the total energy consumed is always very considerable either because the apparent co-efficient of friction, and thus the energy used to drive the belt, are high, the energy used to form and maintain the fluid layer then being small, or because the energy used to form and maintain the fluid layer is high, the apparent co-efficient of friction, and thus the energy used to drive the belt, being then low.

In fact, it is because the total energy consumed is too high that, up to now, fluid conveyors have been little used in spite of the considerable advantages that they offer over roller conveyors in which the conveyor belt is supported by groups of rollers arranged at intervals.

The invention has for an object a fluid conveyor in which the apparent co-efficient of friction is sufficiently small, even when the energy used to form and maintain the fluid layer is small, for the total energy consumed to be itself small, and even lower than the energy consumed by roller conveyors transporting the same load over the same distance.

The invention consists in a belt conveyor having a conveyor belt which moves over a base-plate or enclosure from which it is separated by a layer of fluid, such as air or water, wherein the face of the belt in contact with the fluid is coated with a layer of a polyolefine.

The polyolefin of said layer may be halogenated, and may consist of polyethylene or polytetrafluoroethylene.

In such fluid conveyors, the fluid may be introduced, and the fluid layer formed between the belt and the base-plate or the enclosure by any known means not forming part of the invention. The invention is also not limited as to the nature of the fluid and a gas, such as air, or a liquid, such as water, may be used; neither is the thickness of this layer a feature of the invention. In fact, it has been noted that covering the face of the conveyor belt with a layer of polyolefine or halogenated polyolefine results in a considerable reduction in the apparent co-efficient of friction whatever may be the nature of the fluid used (and therefore its viscosity) and whatever may be

the thickness of the fluid layer.

Amongst the polyolefines which may be used are polyethylene, and particularly polyethylene with a molecular mass equal to or greater than 600,000; in fact it has been established that polyethylene with a high molecular mass has the property of possessing excellent strength over time, when it is on the belt in use, in addition to the well-known property of adhering easily to a rubber belt. Polytetrafluoroethylene, such as that known under the tradename Teflon, may be cited as an example of a suitable halogenated polyolefine.

The layer of polyolefine or halogenated polyolefine is generally thin i.e. for example, between 0.2 mm and 1 mm. This layer may give rise to longitudinal and transverse stiffening in the belt which is liable to make it difficult to turn round the end-pulleys and to form into a trough. To overcome this stiffening, transverse grooves may be made in said layer if the belt is intended to be used flat, and transverse and longitudinal grooves forming a grid-pattern may be made if the belt is intended to be formed into a trough; the grooves may alternatively be inclined symmetrically with respect to the longitudinal axis of the layer so as to produce lozenge-shaped quadrilateral figures.

In order that the invention may be more clearly understood, reference will now be made to the accompanying drawings which show some embodiments thereof by way of example, and in which:—

Fig. 1 shows a test apparatus employing a belt conveyor according to the invention.

Fig. 2 shows a section through the belt shown in Fig. 1 along the line II—II thereof.

Fig. 3 shows a plan view of the lower face of an alternative form of conveyor belt, and

Fig. 4 shows a plan view of the lower face of another embodiment of conveyor belt.

Referring now to the drawings, the apparatus of Fig. 1 was used to conduct tests on different kinds of conveyor belt, and is shown largely in schematic form. This apparatus comprises a conveyor belt running over two end-pulleys 2 and 3, one of which is a driving pulley. The lower face 4 of the belt travels over a cambered enclosure 5, whose shape it follows. The upper wall 6 of this enclosure is provided with orifices 7; the enclosure is supplied with air by a blower (not shown) via a duct 8; a grille 9, which separates the enclosure into two parts, has the effect of putting the upper part of the enclosure at a uniform pressure lower than that of the air coming from the blower but greater than atmospheric pressure. In the test apparatus the belt travels in a flat state.

The air contained in the upper part of the enclosure passes through the orifices 7 and forms a layer of air between the conveyor belt and the upper wall of the enclosure. The tension applied to the conveyor belt gives rise to a uniform pressure at right angles to the cambered upper wall 6 of the enclosure. Thus, without the belt having actually to be loaded, which would require material to be transported, the exact conditions are produced under which a conveyor belt transports material horizontally. By varying the tension of the belt the pressure which it exerts is varied, which enables different loads to be simulated. In the apparatus in Fig. 1 it is therefore the lower part formed by the conveyor belt and the upper wall of the enclosure which represent a fluid conveyor.

In the tests tabulated hereinbelow, the tension applied to the belt corresponded to a load of 300 kg/cm², which was checked by measuring the pressure of the layer of air situated between the belt and the enclosure.

On the one hand, the force required to drive the conveyor belt at a constant speed was measured, and, the size of the simulated load being known, the apparent co-efficient of friction was calculated. On the other hand, the throughput of air, the pressure of the air in the upper part of the enclosure and the pressure of air leaving the orifices 7 were measured; this enabled the aerodynamic power used, which is the energy used to form and maintain the layer of air, to be calculated.

The tests were performed with several conveyor belts 500 mm wide and with the following aerodynamic powers, for each conveyor belt.

Tests marked in the Tables with the coding *a*: 150 watts per linear metre of belt

Tests marked with the coding *b*: 300 watts per linear metre of belt

Tests marked with the coding *c*: 500 watts per linear metre of belt

In all the tests 1 to 6 tabulated below the speed of the belts was 1.8 metres/sec. that is to say, a normal speed for belt conveyors.

Test 1 was a reference test. The conveyor belt was of vulcanised rubber 8 mm thick and was reinforced with a layer of canvas-reinforced cotton fabric. Its lower face did not have a layer of polyolefine.

Test 2. The conveyor belt, shown in Fig. 2, which corresponds to a section of line II—II of Fig. 1 was identical to that in Test 1 except that its lower face was coated with a smooth, layer 10 of polyethylene having a thickness of 0.5 mm and with a molecular mass of approximately 1,000,000. Since this layer of polyethylene stiffened the conveyor belt, it was difficult to mount the latter on the end pulleys and at the conclusion of the trials, this layer had cracks, certain of which penetrated into the rubber of the belt itself.

Test 3. The conveyor belt, of which the lower face is shown in plan in Fig. 3 was identical to that in Test 2, but the layer of polyolefine had transverse grooves 11 separated from one another by 10 mm, with a width of about 1 mm and a depth nearly equal to the

thickness of the layer of polyethylene. In order not to create additional air leaks, these grooves ended at a distance of 15 mm from each edge of the conveyor belt.

The longitudinal flexibility of the belt was considerable and it did not give difficulty when being fitted; its transverse stiffness was considerable but, when the belt is being used flat, this forms more of an advantage than a disadvantage. At the conclusion of the test the layer of polyethylene was intact.

Test 4. The belt was identical to that in Test 3, but the grooves made in the layer of polyethylene extended to the edges of the belt, which gave rise to additional air leaks.

Test 5. The conveyor belt, the lower face of which is shown in plan in Fig. 4, was identical to that in Test 3, but the layer of polyethylene had, in addition to the transverse grooves 11, longitudinal grooves 12 of the same width and depth, also separated by 10 mm: the layer of polyethylene thus exhibited the grid pattern shown in Fig. 4.

This belt had both good longitudinal flexibility and was perfectly amenable to being shaped into a trough, as tests performed elsewhere demonstrated.

Test 6. The belt was identical to that in Test 5 but its lower face was coated with a layer of polytetrafluoroethylene known under the trade-name "Teflon" having the same thickness as the layer of polyethylene on the belt in Test 5 and grooved like the latter.

The conclusion drawn from these tests is that the presence of a layer of polyethylene or polytetrafluoroethylene improves the apparent co-efficient of friction considerably in all cases, it being reduced three times and more; it may also be noted that an aerodynamic power of 150 watts enables an apparent co-efficient of friction to be obtained with a belt coated with a layer of polyethylene or "Teflon" which is lower than that obtained with a power of 500 watts with a belt not having a layer of polyethylene or "Teflon".

Comparison between Tests 2, 3, 4, 5 shows that the presence of grooves, which do, however, give rise to vortex movements, do not cause an increase in the apparent co-efficient of friction; this is a surprising result which, for the moment, cannot be explained. Comparison between Tests 3 and 4 also shows that, contrary to what was feared, the air leaks caused by the grooves running to the edges of the conveyor belt dot not entail any considerable reduction in the apparent co-efficient of friction.

Comparison between Tests 5 and 6 shows that the use of "Teflon" leads to a smaller reduction in apparent co-efficient of friction than the use of polyethylene, but one which is still significant.

The following tests were then performed with a conveyor belt moving at a speed of 6 metres/sec:

Test 7. The conveyor belt was identical to that used in Test 1.

Test 8. The conveyor belt was identical to that used in Test 5.

Test 9. The conveyor belt was identical to that used in Test 6.

The results of all these Tests 1 to 9 are recorded in the table appearing at the end of the Specification.

As could be foreseen, the apparent co-efficients of friction are slightly higher than in the tests in which the conveyor belt moved at lower speed; but the presence of a layer of polyethylene or "Teflon" still reduces the apparent co-efficients of friction to a considerable degree.

The significance of the invention is brought out even more clearly if the total energy necessary per metre length of the belt is calculated to operate a conveyor transporting materials along a straight horizontal path at a constant speed of 6 metres/sec. with a throughput of 3,500 tonnes per hour.

With a conveyor in which the conveyor belt is supported by groups of rollers the apparent co-efficient of friction cannot be less than 2%; under these conditions the power applied will be 270 watts.

With a conveyor in which a layer of air is interposed between the base-plate and the conveyor belt, if the conveyor belt is identical to that in Tests 1 and 7 an energy of 38 watts must be applied to drive the belt, which is not very much, but a power of 480 watts must be applied to form and maintain the layer of air. The total power to be applied will therefore be 518 watts, which is nearly twice that necessary with a roller conveyor. On the other hand: if the conveyor belt is identical to that in Tests 5 and 8, it will be possible to use a power of only 200 watts to form and maintain the layer of air and a power of 19 watts to drive the belt. The total power to be applied will therefore be 219 watts, which is distinctly lower than that required with a roller conveyor.

The invention therefore enables fluid conveyors to be produced having an energy balance-sheet better than that of roller conveyors. The saving in energy which it makes possible is in itself a considerabde advantage. Furthermore, by ensuring that fluid conveyors have a favourable energy balance-sheet, it enables use to be made of their inherent advantages, such as reduced maintenance, deriving from the small number of rotating parts.

TABLE

	Test 1			Test 2			Test 3		
Apparent coefficient of friction in %	1*a*	1*b*	1*c*	1*a*	1*b*	1*c*	1*a*	1*b*	1*c*
	0.65	0.42	0.28	0.22	0.14	0.10	0.25	0.15	0.11

	Test 4			Test 5			Test 6		
Apparent coefficient of friction in %	1*a*	1*b*	1*c*	1*a*	1*b*	1*c*	1*a*	1*b*	1*c*
	0.28	0.21	0.18	0.24	0.16	0.11	0.32	0.26	0.19

	Test 7			Test 8			Test 9		
Apparent coefficient friction in %	1*a*	1*b*	1*c*	1*a*	1*b*	1*c*	1*a*	1*b*	1*c*
	0.74	0.45	0.32	0.29	0.19	0.13	0.38	0.30	0.22

WHAT WE CLAIM IS:—

1. A belt conveyor having a conveyor belt which moves over a base-plate or enclosure from which it is separated by a layer of fluid, such as air or water, wherein the face of the belt in contact with the fluid is coated with a layer of a polyolefine.

2. A conveyor as claimed in claim 1, wherein the polyolefine is polyethylene with a molecular mass greater than 600,000.

3. A conveyor belt as claimed in claim 1, wherein the polyolefine is a halogenated polyolefine.

4. A conveyor as claimed in claim 3, wherein the halogenated polyolefine is polytetrafluoroethylene.

5. A conveyor as claimed in any one of claims 1 to 4, wherein the said layer is grooved.

6. A conveyor as claimed in claim 5, wherein the grooves are terminated before the edges of the belt.

7. A conveyor as claimed in claim 5 or 6, wherein said grooves extend transversely of said layer.

8. A conveyor as claimed in claim 5 or 6, wherein said grooves extend longitudinally of said layer.

9. A conveyor as claimed in claim 5 or 6, wherein said grooves are symmetrically inclined with respect to the longitudinal axis of said layer so as to form quadrilateral figures.

10. A conveyor as claimed in claim 9, wherein the quadrilateral figured are lozenge-shaped.

11. A belt conveyor substantially as hereinbefore described with reference to the accompanying drawings.

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1 SHEET This drawing is a reproduction of the Original on a reduced scale

FIG.1

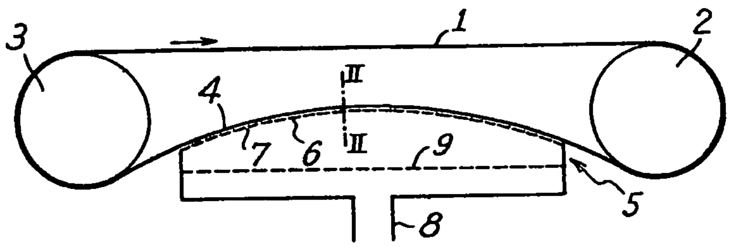

FIG.2

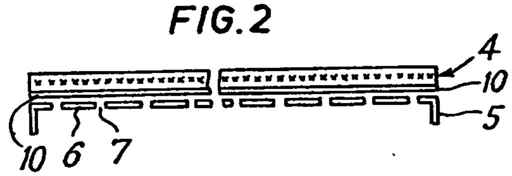

FIG.3

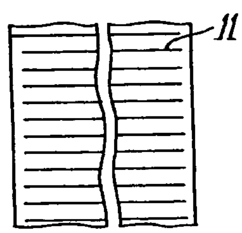

FIG.4